1999 Biological Evaluation
Western Spruce Budworm Analysis Units
Mt. Adams Ranger District
Gifford Pinchot National Forest

WSCFID 99-1

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Introduction

The Gifford Pinchot National Forest is considering western spruce budworm (WSB) suppression using the biological insecticide *Bacillus thuringiensis* Berliner var. *kurstaki* (B.t.k.) in 2000. Protecting function of northern spotted owl core nesting and roosting habitat in the Gotchen Late Successional Reserve is a primary treatment objective. Adjacent private landowners also have expressed deep concern about spread of the outbreak onto their lands and increased fire risk in severely defoliated areas. The purpose of this biological evaluation is to 1) characterize relevant features of the current budworm outbreak on the Gifford Pinchot National Forest, 2) ascertain current damage levels in areas proposed for treatment, 3) predict the additional damage that is likely to occur in 2000, and 4) discuss various treatment options, strategies, and effectiveness.

Background

The western spruce budworm is a native insect with a one-year life cycle that feeds on the foliage of several western conifer species. Primary hosts are Douglas-fir and true firs. Outbreaks occur periodically in susceptible forests, and usually last between 8 and 20 years in the Pacific Northwest. Budworm larvae mine buds and feed on the current-year foliage of host trees during spring and summer. As summer progresses, partially-consumed needles turn red, and affected stands take on an orange to reddish cast. After several consecutive years of heavy defoliation, tree crowns become sparse, tree tops begin to die, and some understory tree mortality may occur. If heavy defoliation repeatedly occurs for many years, some overstory trees also may die.

Budworm outbreaks are part of the natural cycle of events that occur in western fir-dominated forests. Outbreaks reduce forest biomass, accelerate nutrient recycling, and often create predisposing conditions that influence the frequency, distribution, and intensity of wildfire. Wildfire, in turn, strongly influences stand structure and species composition, thus affecting future budworm outbreak extent and intensity.

Forest conditions that favor budworm outbreaks are stands that are dense, multi-storied, and comprised of a high percentage of host species. Historically, forested areas susceptible to budworm outbreaks are believed to have been much smaller, more discreet and patchily distributed than they are today. Prior to European settlement, frequent wildfires favored fire-adapted species such as pines over much of the landscape, and promoted a widely-spaced, simple forest structure. Fire suppression and selective

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logging of pines since the turn of the century has altered forest composition and structure over large, continuous areas, changing the predominant type to one dominated by fir, and changing the predominant structure to a dense, multi-storied condition. These altered forests are quite susceptible to budworm outbreaks and stand-replacing fires.

Stands in the outbreak area are generally dense and multi-layered, with widely scattered, very large and old (250 + years) remnant ponderosa pine and Douglas-fir trees. The main canopy layer is primarily 80 to 90 year old grand fir with some Douglas-fir, and the understory is mostly comprised of intermediate and suppressed grand fir. High levels of root disease, including annosus root rot and armillaria, are found in some areas. Some areas have also experienced significant winter damage (broken tops) during the past 1-4 years. In general, stands grade from east to west from a dry grand fir type, which was historically fire-climax pine, to a moist grand fir type, which historically supported relatively high amounts of true fir. The current outbreak is most severe on sites that were historically fire-climax pine.

The outbreak area lays on the eastside of the Cascade Mountain Range north of the Columbia River and south and east of Mt. Adams (Fig. 1). Since 1994, western spruce budworm has caused defoliation in an area located on the east side of the Gifford Pinchot National Forest. 1999 defoliation (mapped during the annual R6 Aerial Insect Detection Survey) overlays an eastern boundary and stops north of a southern boundary of the Forest (Figs. 1, 2). Budworm-infested Yakama tribal lands, interspersed with private industrial forestlands, and Washington Department of Natural Resources (WDNR) lands are adjacent to the eastern Forest boundary. A mixture of private industrial forestlands and WDNR lands lay next to the southern Forest Boundary. Past aerial surveys have recorded only minor amounts of budworm activity on lands south of the Forest boundary.

A portion of the outbreak overlays most of the Gotchen Late Successional Reserve (LSR) (Fig. 2), which is managed for the protection and enhancement of late succession and old growth species and functions. One of the priority management species in the LSR is the northern spotted owl, which has been listed as a threatened species under the Threatened and Endangered Species Act. Six spotted owl nest sites are located in the LSR. Defoliation can negatively affect spotted owl habitat. Another species of concern in the outbreak area is the mardon skipper, a butterfly that has been proposed for listing as endangered in Washington State (Potter 1999), and also is a candidate species for federal listing. It is unknown whether budworm defoliation affects the mardon skipper or its habitat, but budworm suppression with B.t.k. potentially has negative effects if consumed by the larval stage.

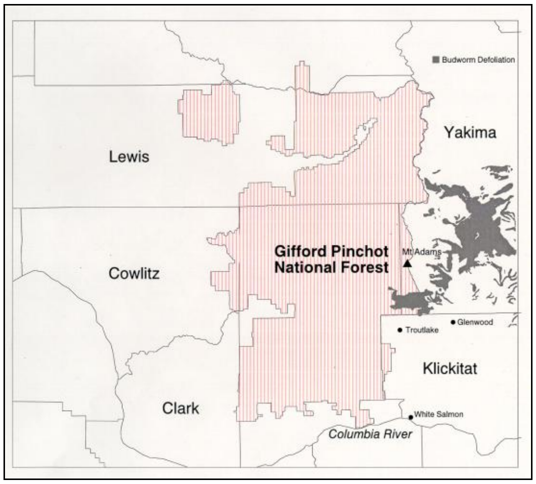

Fig. 1. Vicinity map of Gifford Pinchot National Forest and 1999 western spruce budworm defoliation.

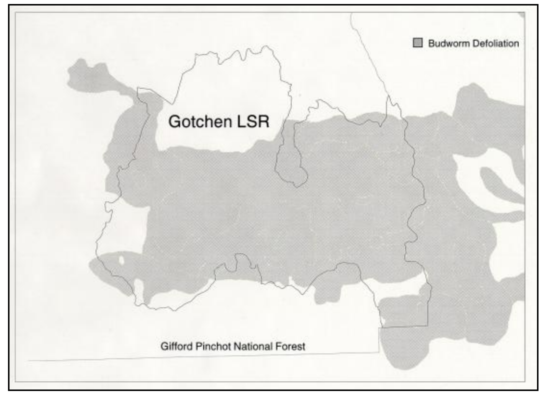

Fig. 2. Vicinity map of Gotchen LSR and 1999 budworm defoliation.

Aerial Survey Records

Western spruce budworm defoliation was first mapped on the Gifford Pinchot National Forest in 1994 (Table 1). No prior occurrences of WSB have been recorded on the Gifford Pinchot National Forest during annual R6 aerial insect detection surveys, which began in 1947. This is likely because much of the area, burned over by large stand-replacing fires at the turn of the century, was in a fairly resistant condition to budworm outbreaks until recently. To date, the majority of the mapped acres of defoliation fall within the Gotchen LSR, and the heaviest defoliation is located in the eastern portion. Farther east, a western spruce budworm outbreak has been continuing since 1985 on Yakama tribal lands, WDNR lands and private industrial forestlands. The area currently affected on the Gifford Pinchot National Forest represents the westernmost extension of that subregional outbreak.

Table 1. Acres of western spruce budworm defoliation by intensity and year on the Gifford Pinchot National Forest (from R6 Aerial Insect Detection Survey, Portland, Oregon).

Intensity	1994	1995	1996	1997	1998[1]	1999
Total	3724	14877	6949	6542	27642	13111
Low (BS1 or L)[2]	3724	14015	461	4143	6581	3457
Moderate (BS2 or M)[2]		862	6097	247	20833	8720
Heavy (BS3+ or H)[2]			391	2152	228	934

[1] Actual extent and intensity was less than indicated here, according to ground information.

[2] Aerial survey mapping codes for budworm defoliation intensity.

Methods

Analysis Unit Delineation

Northern spotted owl habitat requirements drove the delineation process for the six Analysis Units (AUs) located in the Gotchen LSR (Table 2, Fig. 3). Rolando Mendez-Treneman, District Wildlife Biologist, delineated the "best 100 acres" of nesting and roosting habitat for each known nesting pair of northern spotted owls, taking into consideration historical use and existing forest structure. A seventh analysis unit (Boundary AU) was added along the southern boundary of the Forest in response to adjacent landowner concerns over outbreak spread onto their lands. Location, i.e. adjacency to non-Forest timberlands to the south, was the sole factor determining delineation of this Analysis Unit. Boundary AU was originally drawn to encompass a six by one-half mile swath along the southern Forest boundary (Fig. 3), but it was later expanded in November 1999, to include all of the Matrix area south of the Gotchen LSR.

Table 2. Analysis Unit size and management designation per the 1993 Northwest Forest Plan.

Analysis Unit	Acres	Management Designation
Smith	100	LSR
Gotchen	100	LSR
Ground	100	LSR
Big Tree	100	LSR
Buck	100	LSR
Crof	100	LSR
Boundary	5000	Matrix

Sampling Design and Procedures

Sampling strategy followed the Regional guidelines developed by Sheehan et al. (1993). Field sampling was conducted in three phases during summer, 1999: larval sampling, pheromone trapping, and stand data collection.

Larval Sampling

Preliminary Analysis Unit boundaries are usually based on empirical perceptions of tree damage and concern that continuing defoliation will prevent achievement of resource management objectives. The appearance of trees damaged by defoliation improves slowly, but budworm population levels fluctuate and can decline quite suddenly without warning. Larval sampling is used to predict whether budworm population levels will remain high enough to justify treatment the following year. AUs with low populations that fall below an established threshold are eliminated from additional sampling and evaluation for treatment.

Larval densities were sampled in each Analysis Unit using the lower crown beating method developed by Mason, et al. (1989). Douglas-fir and grand fir having branches with new shoots that could easily be reached from the ground were selected as sample trees.

Three lower crown branches from each of five sample trees were sampled at each plot. Lower crown sampling involved beating the apical 18-inch tip of the three branches over a beating cloth. The total number of larvae on all three branches was counted and recorded for each sample tree on a plot.

Larval sampling was conducted between June 23 and July 9. Thirty plots were established in each Analysis Unit, except in the Boundary AU, which had 31 plots. LSR plots were arranged in a systematic grid pattern across each 100-acre AU. Plots in the Boundary AU were located along Forest roads, but were offset at least 100 feet from major roadways to avoid dust.

Pheromone Trapping

Pheromone traps were used to sample the population density of WSB male moths. The number of trapped males is used as an index of total population densities to project expected defoliation levels for the following year.

Traps were placed in five Analysis Units between July 3 and July 29. One trap was placed on the lower branch of a host tree at each larval sampling plot in the Boundary AU, and at every other plot in the Gotchen, Smith, Ground, and Big Tree AUs. The trapping apparatus consisted of milk-carton type traps with tent-like configurations and sticky interiors. Commercially-produced western spruce budworm pheromone baits were placed on a straight pin and attached to the inside of the trap in such a way as to prevent contact between the bait and the sticky coating of the trap interior.

The traps were collected between September 14 and September 30. Field crews counted and recorded the number of western spruce budworm moths per trap.

Stand Measurements

Stand data was collected to provide information on the composition and structure of stands in each Analysis Unit, and on the amount of topkill and defoliation present. Data collection protocols were slightly modified from the standard Region 6 stand exam procedures used on the Mt. Adams Ranger District to include information on budworm defoliation. Variable-radius plots were established using a 40 BAF prism and a breakpoint diameter of 5 inches. Fixed-radius plots 1/100 acres in size were used to measure trees less than 5 inches dbh. Information collected included site characteristics (slope, aspect, location, elevation, plant association) tree characteristics (species, height, diameter at breast height (dbh), crown ratio, crown class), and tree damage (budworm-caused dead top and bare top, current and cumulative defoliation percentages, occurrence and severity of other biotic and abiotic damage agents).

Field crews estimated the percent of missing foliage by crown third on each host sample tree. Beginning with the upper third, each consecutive crown third was assigned values between 0 and 9 to represent the level of defoliation for a) current foliage and b) all foliage, for example, 0 = 0-10% missing foliage, 1 = 11<20% missing foliage, 2 = 21<30%

missing foliage, and so on. As a result, each tree had one three-numeral rating for current defoliation and one three-numeral rating for cumulative defoliation, such as 3,2,1, or 9,9,9. Each crown third rating was then categorized and converted into a crown third index number (Table 3). In a manner similar to the Hawksworth Mistletoe Rating system, these crown third index numbers were added together to give a single-digit defoliation index for the tree.

Table 3. Defoliation ratings and equivalent crown third indices, tree defoliation indices, and intensity values for current and cumulative defoliation.

Crown Third Estimate (**% Defoliation**)	**Crown Third Rating** (**Categories**)	**Crown Third Index**	**Tree Defoliation Index (TDI)**	**TDI Intensity Categories**	**Intensity**
0-10	0	0	Sum of tree's crown third indices; consists of a single number between 0 and 9	0	None to very light
11<40	1,2,3	1		1-3	Light
41<70	4,5,6	2		4-6	Moderate
71-100	7,8,9	3		7-9	Heavy

All stand measurement plots were located at or near larval sampling plots. Data was collected on thirty-one plots in Boundary AU, and on 15 plots in Gotchen, Smith, Ground, and Big Tree AUs. Exams were completed in August and September.

Results

Larval Sampling

Mean larval densities per tree for each Analysis Unit are shown in Table 4. Plot means east to west across the Boundary AU were uniformly low. A mean density of 8 larvae per tree is the established threshold for continuing the evaluation process. Buck AU, Crof AU, and Boundary AU densities were low, and failed to meet or exceed the threshold density for continuing treatment consideration. Subsequently, Buck AU and Crof AU were dropped from further sampling and analysis. Data collection in Boundary AU was continued to provide a full array of information to parties concerned about budworm in this particular area.

Pheromone Trapping

All of the Analysis Units sampled with pheromone traps exceeded the threshold for continuing evaluation of 35 moths per trap except for the Boundary AU (Table 5). Pheromone trap catches in the Boundary AU tended to be high east of Road 80, and low to the west. The estimated relationships between moths caught per trap and predicted defoliation for each Analysis Unit during the subsequent year are shown in Table 6.

Table 4. Average number of larvae per three-branch lower crown sample (one tree) from plots on Mt. Adams Ranger District in 1999.

	Gotchen	**Smith**	**Ground**	**Big Tree**	**Buck**	**Crof**	**Boundary**
Mean	13.09	18.29	23.3	24.65	1.44	1.11	3.26
CI (t*s)	±1.77	±5.57	±7.34	±3.74	±0.37	±0.41	±1.23
Meets Threshold[1]	Yes	Yes	Yes	Yes	No	No	No
Variance	1.08	10.55	18.67	4.83	0.05	0.06	0.56
SE	1.04	3.25	43.21	2.20	0.22	0.24	0.75
SE% (68%)	7.94	17.76	18.55	8.92	15.19	21.67647	22.88
SE% (90%)	13.49	30.44	31.51	15.16	28.31	36.81	37.64
t (90%)	1.699	1.714	1.699	1.699	1.699	1.699	1.645
N (# Plots)	30	24[2]	30	30	30	30	31

[1]Threshold for moderate defoliation the following year (i.e. continue evaluation for treatment) is 8 larvae per three-branch lower crown sample (Sheehan et al. 1993).

[2]Analysis of Smith AU is based upon 24 plots due to missing data for 6 plots.

Table 5. Average number of male moths caught per trap on Mt. Adams Ranger District in 1999.

	Gotchen	**Smith**	**Ground**	**Big Tree**	**Boundary**
Mean	57.2	51.25	74.2	65	34.29
CI (90%)	±0.7	±1	±0.78	±0.53	±0.47
Predicted Defoliation in 2000	Heavy	Heavy	Heavy	Heavy	Light
Variance	468.46	754.2	576.31	262	430.61
StDev	21.64	27.46	24.01	16.19	20.75
N (# Traps)	15	12	15	15	31

Table 6. Pheromone trap catches and predicted defoliation.[1]

Moths per trap	**Predicted Defoliation**	**Intensity**
0-4	Undetectable by cursory observation	Light
5-19	Patchy within some trees	Light
20-34	Most trees lightly defoliated	Light
35-44[2]	Stand moderately defoliated	Moderate
45-55	Heavy defoliation of upper crowns	Heavy
>55	Heavy defoliation of entire crown	Heavy

[1] From Sartwell (retired), PNW Research Station, Corvallis, OR

[2] 35 moths per trap is the threshold used to continue evaluation of Analysis Units for treatment.

Although pheromone trapping is currently the best method available for predicting defoliation, the accuracy of the predictions is somewhat uncertain. Several data sets have shown good correlation between trap catches and subsequent-year defoliation, but field experience has also shown that high trap catches do not always correlate with heavy

defoliation the following year. Because of this uncertainty, it is prudent to regard pheromone trap catches as merely one additional piece of information, and to make treatment decisions after careful consideration of the entire array of available information.

Stand Measurements

All five Analysis Units have high stocking levels and are comprised of a high proportion of budworm host trees, namely grand fir and Douglas-fir (Table 7). Big Tree AU and Boundary AU have less grand fir, and more Douglas-fir and other species than the other three Analysis Units. They also have more pine trees per acre and more small diameter ponderosa pines.

Table 7. Summary of trees per acre, basal area, and quadratic mean diameters in Analysis Units on the Gifford Pinchot National Forest, 1999.

	Gotchen	Smith	Ground	Big Tree	Boundary
Trees/Acre	356.8	296.3	369.1	313.9	545.4
% Grand fir	94.6	93.7	89.4	72.7	61.2
% Douglas-fir	3.4	2.1	9.0	17.5	25.2
% Pine[1]	2.1	4.0/0.2[2]	1.6	9.8	5.9
% Other sp.	0	0	0	0	7.7
% Host	98.0	95.8	98.4	90.2	86.4
Basal Area[3]	321.4	151.9	227.5	192.3	176.7
% Grand fir	71.0	84.6	71.7	52.3	27.9
% Douglas-fir	15.8	8.8	17.8	35.1	56.6
% Pine	13.3	2.2/4.4[2]	10.5	12.6	13.1
%Other sp.	0	0	0	0	2.4
% Host	86.8	93.4	89.5	87.4	84.7
QMD[4]	14.6	12.7	11.4	12.6	14.0
Grand fir	12.7	12.1	10.3	11.2	11.7
Douglas-fir	27.8	19.9	15.0	15.0	16.2
Pine	32.6	13.3/41.8[2]	27.2	16.0	18.1

[1]Denotes ponderosa pine unless otherwise noted.
[2]Lodgepole pine and ponderosa pine, respectively.
[3]Square feet per acre.
[4]Quadratic mean diameter, which is the diameter of a tree of average basal area.

Within the four Analysis Units in the Gotchen LSR, nearly every host tree sampled had evidence of some level of defoliation (Table 8). In contrast, only a very small proportion of the trees sampled in the Boundary AU showed any sign of budworm defoliation. The relative amount of cumulative, or total defoliation on all host trees is displayed for each Analysis Unit in Table 9. Host trees in Gotchen, Smith, Ground, and Big Tree Analysis Units had approximately equal proportions of light, moderate, and heavy defoliation, while nearly 96 percent of the host trees in the Boundary AU had no defoliation.

Table 8. Proportion of host trees and host basal area with budworm defoliation.

	Gotchen	Smith	Ground	Big Tree	Boundary
Trees/acre	97.9	98.7	100	81.6	4.3
Basal area[1]	99.0	93.0	93.6	83.6	12.3

[1]Square feet per acre.

Table 9. Percent trees per acre of Douglas-fir and grand fir by cumulative Tree Defoliation Index[1] and Analysis Unit.

Analysis Unit	0 None	1-3 Light	4-6 Moderate	7-9 Heavy
Gotchen	2.11	33.27	30.18	34.44
Smith	1.64	25.53	34.53	38.29
Ground	1.27	35.56	24.41	38.77
Big Tree	18.43	52.39	19.23	9.95
Boundary	95.72	4.28	0.00	0.00

[1]See p. 5 for derivation of index values.

Bare top and dead top occurrence are influenced by tree canopy position, severity and number of years of defoliation, and species tolerance to defoliation. No dead tops were recorded in any of the Analysis Units. Bare top data (Table 10) indicate that some trees may begin to experience topkill during the next year if the outbreak continues. Gotchen AU had the highest levels of trees with bare, or completely defoliated tops (27.65 %). Big Tree had the next highest levels (12.69%), followed by Ground (7.87%), Smith (7.47%) and Boundary (4.05%). In Gotchen AU, Smith AU, and Boundary AU, three-quarters or more of the bare tops occurred on trees 6 inches dbh or smaller.

Table 10. Percent trees per acre with bare tops caused by budworm feeding.

Bare Top[1]	0	1<10%	10<20%	20<30%	>30%
Gotchen					
Total Host	**72.35**	**23.32**	**4.33**	**0**	**0**
Grand fir	72.77	22.74	4.48	0	0
Douglas-fir	60.47	39.53	0	0	0
Smith					
Total Host	**92.52**	**7.47**	**0**	**0**	**0**
Grand fir	92.36	7.64	0	0	0
Douglas-fir	100.00	0	0	0	0
Ground					
Total Host	**92.13**	**7.87**	**0**	**0**	**0**
Grand fir	92.46	7.54	0	0	0
Douglas-fir	90.47	9.53	0	0	0

Big Tree					
Total Host	**87.32**	**12.69**	**0**	**0**	**0**
Grand fir	87.04	12.97	0	0	0
Douglas-fir	88.48	11.52	0	0	0
Boundary					
Total Host	**95.95**	**2.00**	**2.05**	**0**	**0**
Grand fir	94.88	2.22	2.9	0	0
Douglas-fir	98.55	1.45	0	0	0

[1] Bare top categories are based upon the relationship of bare top length to total tree height.

Discussion and Recommendations

Budworm management strategies

Two types of management treatments reduce the impacts of western spruce budworm outbreaks, insecticide application (direct suppression) and silvicultural manipulation (indirect suppression and prevention). Insecticide applications are usually effective in reducing budworm population numbers within the treated area. However, they have been shown to have only a temporary effect on defoliation (Sheehan, 1996; Torgersen et al. 1995) and budworm population numbers (Torgersen et al. 1995), and may kill other non-target lepidopteran larvae that are feeding within the treated area at the time of treatment (Miller 1992). Silvicultural manipulation that promotes stand conversion to non-host species and lower stocking levels, utilizing such practices as regeneration harvest and thinning from below, is an effective long-term strategy that can reduce the abundance, continuity, and quality of budworm habitat. During an outbreak, however, thinning activities do not prevent defoliation from occurring on the remaining host trees.

Various treatment strategies to reduce western spruce budworm impacts have been tried or proposed. Following is a brief discussion of each strategy and what is known of its effectiveness:

1) **Preemptive strikes on a landscape scale using insecticide applications to stop an outbreak by reducing populations in defoliated areas and preventing dispersal to non-defoliated areas.** Single-application insecticide treatments on a landscape level are ineffective in affecting defoliation levels in areas outside treatment zones (Sheehan, 1996) or altering the course of an outbreak. Effective spray treatments can lower budworm population densities, but do not change the underlying environmental conditions that are conducive to population buildup. High larval mortality is difficult to obtain consistently through aerial spraying (Shepherd, 1994), and most spray projects are considered successful when the post-treatment mortality rate is 85% or higher. Thus a “successful” spray project potentially leaves as much as 15% of the budworm population alive in habitat that is favorable to rapid population increase, and populations return in one to two years to levels present before spray application. Repeated annual treatment of a large landscape is undesirable because it is costly in terms of both human resources and

dollars, and has a higher probability of causing unacceptable effects to some non-target species.

2) **Boundary spray between defoliated and non-defoliated areas to stop the spread into non-defoliated areas.** Ineffective because budworm adults are good fliers and also may be carried many miles (over the treated areas) by prevailing winds and storm fronts.

- **Foliage protection through targeted, repetitive (if necessary) spray treatments.** Spray treatments have been shown to be effective in reducing budworm larval densities and defoliation (measured from the ground) for one to two years (Torgersen et al., 1995), and in reducing defoliation (as mapped during aerial surveys) for generally one year (Sheehan, 1996). As a general rule, insecticide applications should be used only in those areas where significant adverse effects to managed resources are anticipated and where silvicultural management activities that will reduce budworm hazard are planned in the near future.

3) Stand conversion to non-host species. Effectively destroys budworm habitat.

4) Hazard reduction for budworm using a mixture of silvicultural techniques such as thinning from below, regeneration cutting, and planting of non-host species to diversify the landscape. Effective to the degree that it increases the proportion of non-host species, simplifies canopy layering to a single stratum, reduces stocking to reasonable levels, and promotes tree vigor.

Gotchen LSR Analysis Units

Gotchen LSR Analysis Units include Gotchen AU, Smith AU, Ground AU, Big Tree AU, Buck AU and Crof AU. Buck AU and Crof AU were dropped from the evaluation process in July following larval sampling because of low populations. Aerial survey data indicated no defoliation or light defoliation in the vicinity of these AUs in 1999. Gotchen AU, Smith AU, Ground AU, and Big Tree AU, however, had relatively high larval populations that significantly exceeded the threshold for continuing evaluation. During 1999 aerial surveys, moderate defoliation was mapped in the vicinity of Gotchen, Smith, and Ground AUs, and light defoliation was mapped around Big Tree. Aerially-visible light to moderate defoliation has been recorded in these areas during five of the six outbreak years. Stand data indicate moderate to high cumulative defoliation levels in all four Analysis Units, especially in the easternmost units, Gotchen, Smith, and Ground. Continued heavy defoliation is likely, as pheromone trap data predict heavy defoliation in these areas during 2000.

As previously noted, insecticide applications are generally recommended for use only in those areas where significant adverse effects to managed resources are anticipated and where silvicultural management activities that will reduce budworm hazard are planned in the near future. Due to the management objectives and current constraints on stand manipulation in Late Successional Reserves, silvicultural treatment to reduce budworm hazard in the owl core stands is not an available option, for reduction of budworm hazard through silvicultural treatment would also destroy the stand characteristics required for nesting and roosting habitat by the northern spotted owl. This paradox has fostered the adoption of a landscape-level strategic approach to the budworm situation in the owl core

areas, in which a mixture of short-term and long-term treatments is considered across the landscape. Small-scale silvicultural treatments that would promote some increases in non-host species and tree vigor would be conducted in stands surrounding the owl core areas, and larger-scale treatments would occur in the Matrix area south of the LSR. On lands to the east of the LSR, the Yakama Nation and private industrial landowners are conducting large-scale stand conversion to non-host and thinning activities, as well as direct suppression activities using insecticides, in response to budworm defoliation on their lands.

Given the above considerations, insecticide treatment is recommended to reduce budworm impacts in these core areas. A targeted approach to spraying will meet resource protection needs while minimizing deleterious effects to non-target organisms. Particular consideration should be given to mitigating possible impacts to known mardon skipper sites. Managers should realize that repeated insecticide applications might be necessary every 1-2 years throughout the duration of this and any future budworm outbreak.

Matrix Area Analysis Unit

Boundary Analysis Unit encompassed an area approximately six miles long and one-half mile wide along the southern Forest boundary when sampled in summer, 1999. This area has experienced very little defoliation, according to aerial survey and stand measurement data. Budworm larval populations were uniformly very low across the unit, and fell well below the minimum threshold for continuing evaluation for treatment in 2000. Pheromone trap catches averaged just below the minimum threshold for prediction of moderate defoliation in 2000. Even if pheromone trap catches had predicted heavy defoliation in this area for 2000, this area would not be recommended for treatment because it does not meet the minimum criteria for treatment consideration, i.e. two or more years of moderate or one or more years of heavy defoliation mapped during the annual R6 Aerial Insect Detection Survey (Sheehan et al. 1993). Therefore, this area would not be recommended for treatment in 2000.

In November 1999, the Boundary Analysis Unit was expanded to include the entire Matrix area south of the Gotchen LSR and north of the Forest boundary. Because this expansion occurred too late in the season for additional sampling to occur, there are no data available for the majority of this area other than aerial survey records. Aerial survey data indicate that various portions of the Matrix have experienced intermittent defoliation since 1994. Most of the defoliation was light, though a few years of moderate to heavy defoliation were recorded in some areas immediately adjacent to the southern boundary of the eastern half the Gotchen LSR. During 1999, defoliation was not recorded in the Matrix except in a couple of areas along the southern boundary of the Gotchen LSR. It is difficult to say, given the difficulties in accurately mapping budworm defoliation boundaries, how large an area this actually represents. Although some areas in the Matrix may have stand damage and budworm populations high enough to warrant insecticide treatment (given management objectives that would justify budworm suppression), the Matrix area considered as a whole would not meet the minimum criteria for treatment consideration. In addition, broadcast spraying a large and diverse area such as the Matrix poses a higher risk to non-target organisms than the LSR Analysis Units because a wider spectrum of

habitats would be subjected to insecticides, and non-target populations over a large area potentially could be depressed, slowing the rate of recolonization for species significantly affected by the insecticide.

Based on the low levels of budworm populations and stand damage present throughout the majority of the Matrix area, the expanded Boundary Analysis Unit is not recommended for treatment in 2000. Continued monitoring of this area for budworm population densities and defoliation intensity is highly recommended.

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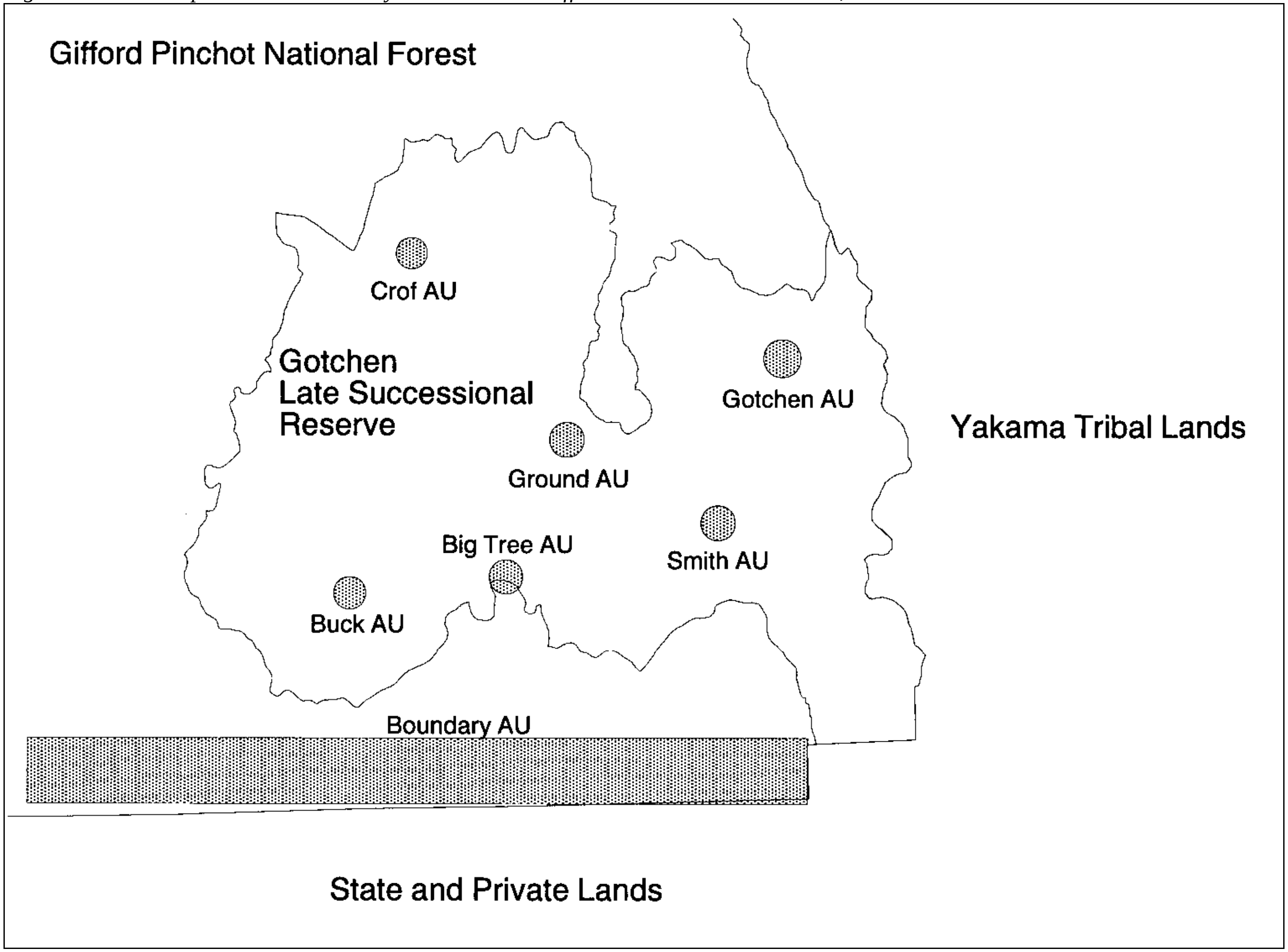
Figure 3. Western spruce budworm analysis units on the Gifford Pinchot National Forest, 1999.[1]



[1]Boundary Analysis Unit original boundaries, sampled for western spruce budworm in summer, 1999. Boundary AU was extended northward to the southern edge of Gotchen LSR in November, 1999.